MULTIMEDIA UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 3, 2017/2018**

## DEM5038 – ENGINEERING MATHEMATICS 3
( Diploma in Electronic Engineering )

31 MAY 2018
2.30 P.M. – 4.30 P.M.
( 2 Hours )

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**INSTRUCTIONS TO STUDENT**

1. This question paper consists of **5** pages with **4** questions only (3 pages for questions and 2 pages for appendices).
2. Answer **ALL** questions. All necessary working steps must be shown.
3. Write all your answers in the answer booklet provided.

**Please answer ALL questions and show the necessary working. Total mark is equal to 100.**

## Question 1

a) Find the general solution of the differential equation $y''-2y'-3y=6$. (8 marks)

b) Find the general solution of differential equation $y''+4y'+5y=2e^{-2x}$, if $y(0)=1$ and $y'(0)=-2$. (17 marks)

**[25 marks]**

## Question 2

a) If the function of period $2L=4$ which is given on the interval $(-2,2)$ by

$$f(x)=\begin{cases} 0, & -2<x<0 \\ 2-x, & 0<x<2 \end{cases}$$

Find the Fourier Series of $f(x)$. (17 marks)

b) Consider the function $f(x)=2x$, $0<x<1$. Find the Fourier cosine series of $f(x)$. (8 marks)
[Hint: use even half-range expansion]

**[25 marks]**

## Question 3

a) Determine $\mathcal{L}\{te^{-2t}\}$. (3 marks)

b) Find $\mathcal{L}^{-1}\left\{\frac{6}{(s-2)(s+3)}\right\}$. (5 marks)

c) Use Laplace transforms to solve $y''+5y'+6y=2e^{-t}$ subject to the initial conditions $y(0)=1$ and $y'(0)=0$. (17 marks)

**[25 marks]**

**Continued…**

**Question 4**

a) The probability of student A is being chosen as committee of SRC (Student Representative Council) is $\frac{2}{7}$ while the probability of student B being chosen is $\frac{3}{5}$. Find the probability that only one student is chosen as a committee of SRC. (3 marks)

b) A traffic engineer is interested in the number of vehicles reaching a particular crossroad during periods of relatively low traffic flow. The engineer finds that the number of vehicles X reaching the cross roads per minute is governed by the probability distribution:

| $x$ | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| $P(X=x)$ | 0.37 | 0.39 | 0.19 | 0.04 | 0.01 |

Calculate the

i. expected value (2 marks)

ii. standard deviation (3 marks)

of the random variable $X$.

c) In a survey carried out by students from CDP Multimedia University, it is found that 3 out of 10 students are capable of tongue rolling. If 12 students are chosen at random, calculate

i. the probability that at most 2 students are capable of tongue rolling. (2 marks)

ii. the standard deviation of the student who are capable of tongue rolling. (2 marks)

d) If average, 5.6 shoplifting incidents occur per week at an electronics store. Given a certain week at this store, find the probability more than 2 incidents will occur in one day. (3 marks)

**Continued...**

e) In previous study by the MMU Student Council claims that students spend on average of 9.5 hours a day on social media. A new survey has been conducted recently to test this claim. A random sample of 62 students was selected and it is found that they spend on average of 7.8 hours and a standard deviation of 5.35 hours a day on social media. Is there any evidence to reject the claim by the MMU Student Council? Test at 10% level of significance. (10 marks)

**[25 marks]**

**End of Page.**

## APPENDICES

**Quadratic formula** $m = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

**Differential Equation**

| Roots | General Solution |
|---|---|
| $m_1 \neq m_2$ | $y = A e^{m_1 x} + B e^{m_2 x}$ |
| $m_1 = m_2$ | $y = (A + Bx)e^{mx}$ |
| $m = \alpha \pm \beta i$ | $y = e^{\alpha x}(A\cos\beta x + B\sin\beta x)$ |

**Annihilator for special functions**

| Annihilator | |
|---|---|
| $D^n$ | $1, x, x^2, x^3, x^4, \ldots\ldots, x^{n-1}$ |
| $(D-a)^n$ | $e^{ax}, xe^{ax}, x^2e^{ax}, x^3e^{ax}, x^4e^{ax}, \ldots\ldots, x^{n-1}e^{ax}$ |
| $\left(D^2 - 2aD + (a^2 + b^2)\right)^n$ | $e^{ax}\cos bx, xe^{ax}\cos bx, x^2e^{ax}\cos bx, x^3e^{ax}\cos bx, \ldots\ldots, x^{n-1}e^{ax}\cos bx$ and $e^{ax}\sin bx, xe^{ax}\sin bx, x^2e^{ax}\sin bx, x^3e^{ax}\sin bx, \ldots\ldots, x^{n-1}e^{ax}\sin bx$ |

**Fourier Series**

$$F(x) = a_0 + \sum_{n=1}^{\infty}\left(a_n \cos\frac{n\pi}{L}x + b_n \sin\frac{n\pi}{L}x\right)$$

$$a_0 = \frac{1}{2L}\int_{-L}^{L} f(x)\,dx$$

$$a_n = \frac{1}{L}\int_{-L}^{L} f(x)\cos\frac{n\pi}{L}x\,dx$$

$$b_n = \frac{1}{L}\int_{-L}^{L} f(x)\sin\frac{n\pi}{L}x\,dx$$

**Integration Formula**

$$\int \sin ax\,dx = -\frac{1}{a}\cos ax$$

$$\int \cos ax\,dx = \frac{1}{a}\sin ax$$

$$\int x\sin ax\,dx = \frac{1}{a^2}(\sin ax - ax\cos ax)$$

$$\int x\cos ax\,dx = \frac{1}{a^2}(\cos ax + ax\sin ax)$$

$$\int x^2\sin ax\,dx = \frac{1}{a^3}(2ax\sin ax + 2\cos ax - a^2x^2\cos ax)$$

$$\int x^2\cos ax\,dx = \frac{1}{a^3}(2ax\cos ax - 2\sin ax + a^2x^2\sin ax)$$

**Transformation of some functions**

| $f(t)$ | $L\{f(t)\}$ |
|---|---|
| $1$ | $\frac{1}{s}$, $s>0$ |
| $t$ | $\frac{1}{s^2}$ |
| $t^n$ | $\frac{n!}{s^{n+1}}$ <br> $n = 1,2,3,\ldots$ |
| $e^{at}$ | $\frac{1}{s-a}$, $s>a$ |
| $t\,e^{at}$ | $\frac{1}{(s-a)^2}$ |
| $y'$ <br> $y''$ | $sY(s)-y(0)$ <br> $s^2Y(s)-sy(0)-y'(0)$ |

| $f(t)$ | $L\{f(t)\}$ |
|---|---|
| $\sin \omega t$ | $\frac{\omega}{s^2+\omega^2}$ |
| $\cos \omega t$ | $\frac{s}{s^2+\omega^2}$ |
| $\sinh \omega t$ | $\frac{\omega}{s^2-\omega^2}$ |
| $\cosh \omega t$ | $\frac{s}{s^2-\omega^2}$ |
| $(1)u(t-a)$ | $\frac{e^{-sa}}{s}$ |
| $(t-a)u(t-a)$ | $\frac{e^{-sa}}{s^2}$ |

**Second Shift Theorem**

$$L\{f(t-a)u(t-a)\} = e^{-as}L\{f(t)\}$$
$$L\{f(t)u(t-a)\} = e^{-as}L\{f(t+a)\}$$

**Binomial Probabilities** $\binom{n}{x}p^x q^{n-x}$

**Key formula for Poisson Probability Distribution :**

- If $\mu = \lambda$
  - i. $P(X=r) = Poi(r) - Poi(r-1)$
  - ii. $P(X \geq r) = 1 - Poi(r-1)$
  - iii. $P(X \leq r) = Poi(r)$
  - iv. $P(X > r) = 1 - Poi(r)$
  - v. $P(X < r) = Poi(r-1)$
  - vi. $P(a \leq X \leq b) = Poi(b) - Poi(a-1)$

**Binomial Formulae when using Cambridge Statistical Table**

Key Formulas (if $p \leq 0.5$)

1. $P(X=r) = B(r) - B(r-1)$
2. $P(X \geq r) = 1 - B(r-1)$
3. $P(X > r) = 1 - B(r)$
4. $P(a \leq X \leq b) = B(b) - B(a-1)$
5. $P(X \leq r) = B(r)$

Key Formulas (if $p > 0.5$)

1. $P(X=r) = P(Y=n-r) = B(n-r) - B(n-r-1)$
2. $P(X \geq r) = P(Y \leq n-r) = B(n-r)$
3. $P(X \leq r) = P(Y \geq n-r) = 1 - B(n-r-1)$
4. $P(a \leq X \leq b) = P(n-b \leq Y \leq n-a)$
   $= B(n-a) - B(n-b-1)$

**Normal Distribution** $Z = \dfrac{X-\mu}{\sigma}$

**Hypothesis Testing**

| | Mean | Proportion |
|---|---|---|
| **One Population** | $z = \dfrac{\bar{x}-\mu_0}{\sigma/\sqrt{n}}$ | $Z = \dfrac{p-p_0}{\sqrt{p_0(1-p_0)/n}}$ |